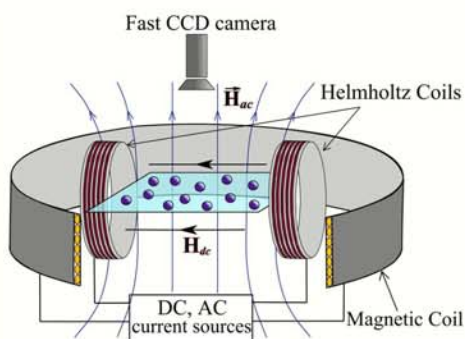


Dynamic self-assembly of magnetic microparticles: surface wave assisted magnetic exchange

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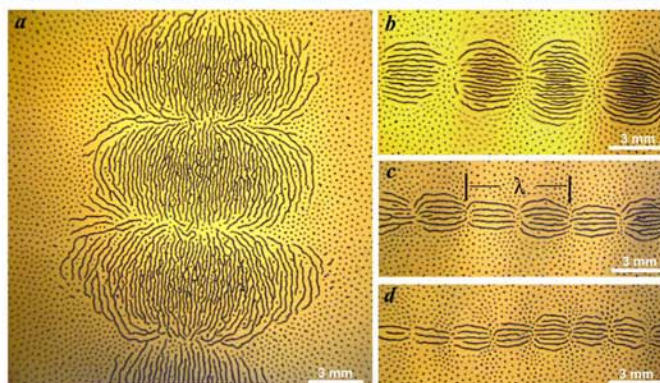
Self-assembly constitutes one of the greatest hopes to nanoscience. We recently discovered magnetically ordered dynamic self-assembled structures induced in an ensemble of magnetic microparticles at the liquid/air interface by a carefully selected alternating magnetic field. Our results give new insights into the onset of collective behavior in multi-particle systems and may be applicable to a broad set of technological applications relevant to a control of micro and nano particles.

Experimental setup



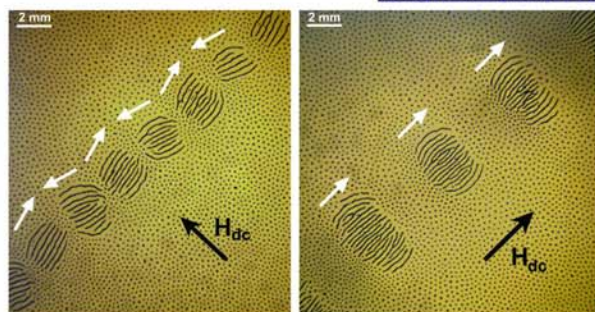
Particles: 45-100 μm Nickel spherical particles.
Base fluid: water.
Alternating magnetic field: 0-120 Oe.
Magnetic in-plane field: 0-30 Oe.

Dynamic self-assembled structures at the liquid/air interface

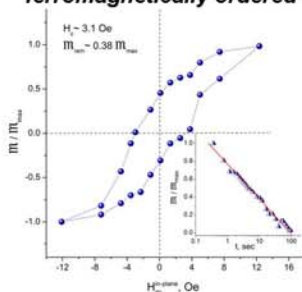


Dynamic multi-segment self-assembled structures generated by 110 Oe alternating magnetic field. The size of the segments is determined by the magnetic field frequency. Panels (a), (b), (c), and (d) represent structures generated at 17 Hz, 30 Hz, 50 Hz, and 70 Hz, respectively.

Magnetic properties of the generated structures

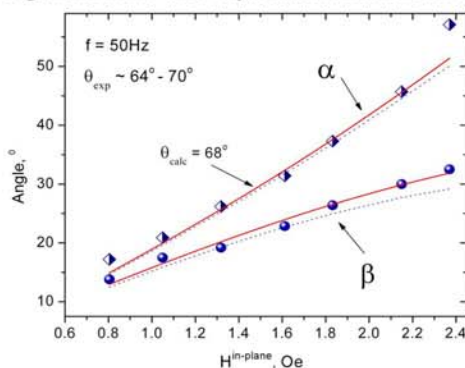


The segments of the "snake" exhibit long-range antiferromagnetic ordering between segments mediated by the surface waves, while each segment is composed of ferromagnetically ordered chains of microparticles.

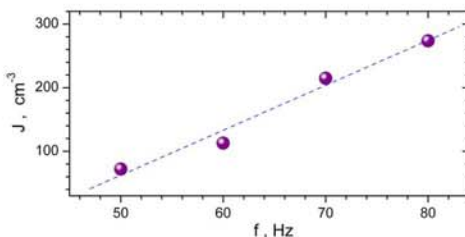


The generated structures exhibit magnetic hysteresis behavior with respect to an external in-plane magnetic field and logarithmic relaxation of the remanent magnetic moment

External in-plane magnetic field deviates the orientation of the segments from their equilibrium orientation along the structure's axis



Deviation angles corresponding to different magnetic sublattices of the structure as a function of an external in-plane magnetic field



Effective exchange constant associated with surface wave assistance at different regimes of magnetic driving

Future plans:

- Investigation of nonlinear flow generation in magnetically driven systems of magnetic microparticles
- Dynamic self-assembly of magnetic submicron and nano particles (effect of particle size reduction on the magnetically driven self-assembly)
- Effect of particle shape anisotropy on the dynamic self-assembly

A. Snezhko, I. Aranson, W. Kwok, *Physical Review Letters* (in print)